255a The Glass Transition and Physical Aging Behavior of Polymer Nanocomposites Studied Via Fluorescence

Perla Rittigstein, Rodney D. Priestley, and John M. Torkelson

Polymer nanocomposites have the potential to exhibit markedly improved thermal, mechanical, optical and physico-chemical properties when compared to the bulk polymer or conventional composites. The degree of interaction between the polymer chains and the surface of the nanoparticles, the method of preparation of the sample, and the diameter of the nanofiller can drastically alter the chain segmental mobility and limit the number of conformations of the polymer, changing the properties of the system.

Fluorescence intensity measurements of chromophore-doped polymer has been used to determine the effects of different silica nanosphere concentrations on the glass transition temperature behavior of thick polystyrene (PS), poly(methyl methacrylate) (PMMA) and poly(2-vinylpyridine) (P2VP) films. It was found that the glass transition temperature (Tg) of PS is not impacted with the addition of silica nanofiller. In contrast, using the same preparation method, the addition of silica nanofillers (10-15 nm of diameter) in a P2VP matrix has great impact, causing Tg to increase dramatically. For instance, a filler concentration of only 0.4 V% causes an increase in Tg of 10 °C compared to the neat polymer. The Tg behavior of the PMMA silica nanocomposites falls in between those of PS and P2VP nanocomposites. Also, it was investigated how the method of preparation of the polymer nanocomposite can impact the dispersion of the nanofiller in the polymer matrix, altering the Tg of the material. Transmission electron microscopy (TEM) was used to characterize the dispersion of the different polymer nanocomposites. In addition, the dependence of Tg in polymer nanocomposites with respect to average interparticle distance was compared to the dependence of Tg in silica capped films (model polymer nanocomposites) with respect to its film thickness.

The use of different nanofillers can lead to attractive or repulsive interaction with the polymeric matrix, changing the trend of Tg with respect to the amount of the nanofiller in the system. An example is presented by comparing the Tg increment obtained in P2VP-silica, P2VP-alumina and PMMA-silica nanocomposites with the decrement of Tg in PMMA-alumina nanocomposites. Rates of physical aging of these polymer nanocomposites are also currently under study using fluorescence intensity methods.